OHIO RIVER BASIN PRECIPITATION FREQUENCY PROJECT

Update of *Technical Paper No. 40, NWS HYDRO-35* and *Technical Paper No. 49*

Twenty-fourth Progress Report
1 July 2005 through 30 September 2005

Office of Hydrologic Development
U.S. National Weather Service
National Oceanic and Atmospheric Administration
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DISCLAIMER

The data and information presented in this report are provided only to demonstrate current progress on the various technical tasks associated with this project. Values presented herein are NOT intended for any other use beyond the scope of this progress report. Anyone using any data or information presented in this report for any purpose other than for what it was intended does so at their own risk.

Table of Contents

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1. Introduction

The final product for the Ohio River Basin and Surrounding States Precipitation Frequency Project, including documentation, is available as NOAA Atlas 14 Volume 2 "Precipitation Frequency Atlas of the United States." It is available on the Internet through the Precipitation frequency Data Server at http://www.nws/noaa/gov/ohd/hdsc. NOAA Atlas 14 Volume 2 includes estimates for Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maryland, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia.

The Hydrometeorological Design Studies Center (HDSC), Hydrology Laboratory, Office of Hydrologic Development, NOAA National Weather Service updated its precipitation frequency estimates for the Ohio River Basin and surrounding states. Previous precipitation frequency estimates for this area were contained in *Technical Paper No. 40* "Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years" (Hershfield, 1961), *NWS HYDRO-35* "Five- to 60-minute precipitation frequency for the eastern and central United States" (Frederick et al., 1977) and *Technical Paper No. 49* "Two- to ten-day precipitation for return periods of 2 to 100 years in the contiguous United States" (Miller et al., 1964). The update included data collection and quality control, dataset formatting, regional frequency analyses, frequency distribution selection and fitting techniques, spatial interpolation and documentation.

The project determined all-season precipitation frequencies for durations from 5 minutes to 60 days, for average recurrence intervals from 2 to 1,000 years. For the project, HDSC reviewed and processed all generally available rainfall data for the project area and used accepted statistical methods. Documentation and project results are published as Volume 2 of NOAA Atlas 14 on the internet (http://www.nws.noaa.gov/ohd/hdsc) with the additional ability to download digital files.

2. Highlights

HDSC will calculate and include the 1-year average recurrence interval (ARI) precipitation frequency estimates for this project. Additional information is provided in Section 3.1, 1-year Estimates.

HDSC continuously monitors the hits, integrity and performance of the Precipitation Frequency Data Server (PFDS), the on-line portal for all NOAA Atlas 14 deliverables and information. Additional information is provided in Section 3.2, PFDS.

Progress on the development of areal reduction factors remains slow. Two statistical and objective testing procedures are being applied and reviewed to ultimately detect differences in the ARF curves for the various sites. Additional information is provided in Section 3.3, Areal Reduction Factors.

3. Progress in this Reporting Period

3.1 1-year Estimates

HDSC will calculate and include the 1-year average recurrence interval (ARI) precipitation frequency estimates for this project. ARI is the average period between each exceedance and is associated with the partial duration series (PDS). Annual exceedance probability (AEP) is the probability that a particular level of rainfall will be exceeded in any particular year (at a particular location and duration) and is derived using the annual maximum series (AMS). An AEP depth or intensity may be exceeded once or more than once in a year.

A 1-year AEP estimate, associated with AMS, has little meaning statistically or physically. However, the 1-year ARI, associated with PDS, is used in several practical applications. The equation $T_{PDS} = [\ln(\frac{T_{AMS}}{T_{AMS}-1})]^{-1}$ (Chow et al., 1988), which is distribution free, provides a mathematical base for converting return periods between the AMS data and the PDS data. Here, T_{AMS} and T_{PDS} stand for the return period of the AMS data and the return period of the PDS data, respectively. The equation can be transformed into the following:

$$T_{AMS} = \frac{1}{1 - e^{-\frac{1}{T_{PDS}}}}$$

Therefore, T_{AMS} = 1.58-year when T_{PDS} = 1-year from the equation. This means that a PDS, or ARI, 1-year event is equivalent to an AMS, or AEP, 1.58-year event. This relationship will be used to calculate the 1-year ARI from AMS data for this project. PDS quantiles for all ARIs other than 1-year were obtained by analyzing both AMS and PDS data separately, averaging ratios of PDS to AMS quantiles and then applying the average ratio to the AMS results.

It is worth noting that the above equation only establishes the relationship between AMS return periods and PDS return periods. It is not a relationship between AMS quantiles and PDS quantiles. However, the theoretical equation can be used to validate the empirical relationship obtained from the real data in a region. For instance, according to the equation, a 2-year AMS quantile is equivalent to a 1.44-year PDS quantile. As an example, Figure 1 shows that 2-year AMS and 1.44-year PDS quantiles are consistent with this relation (i.e., had a high correlation) using daily region 36 of the Ohio River basin and surrounding states project. To further substantiate the relationship, particularly for the use in calculating the 1-year ARI, empirical ratios for the theoretically equivalent 1.77-year AMS and 1.2-year PDS quantile pair were also used to validate the appropriateness of the theoretical equation in generating the 1-year ARI using the 1.58-year AEP. The 1-year ARI estimates are still under internal review but will be made available via the PFDS as soon as they are ready.

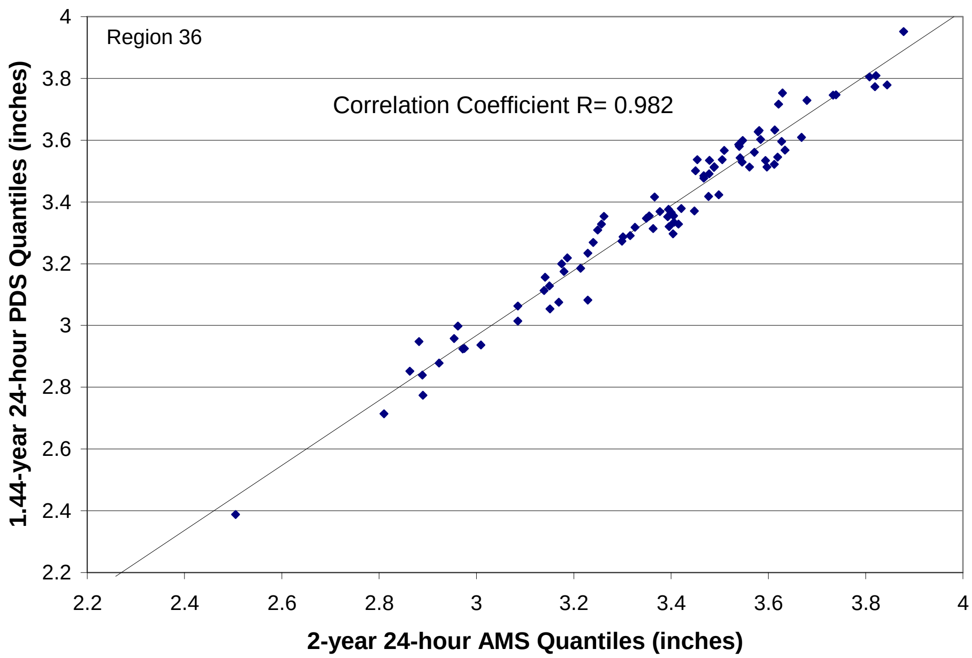

Figure 1. 2-year 24-hour AMS versus 24-hour 1.44-year PDS for daily region 36 from NOAA Atlas 14 Volume 2.

3.2 Precipitation Frequency Data Server

HDSC continuously monitors the hits, integrity and performance of the PFDS, which continues to receive an increasing number of hits per month. The graph (Figure 2) below summarizes the number of individual data inquires made since January 2004, while the map (Figure 3) indicates the locations of inquires during the past quarter.

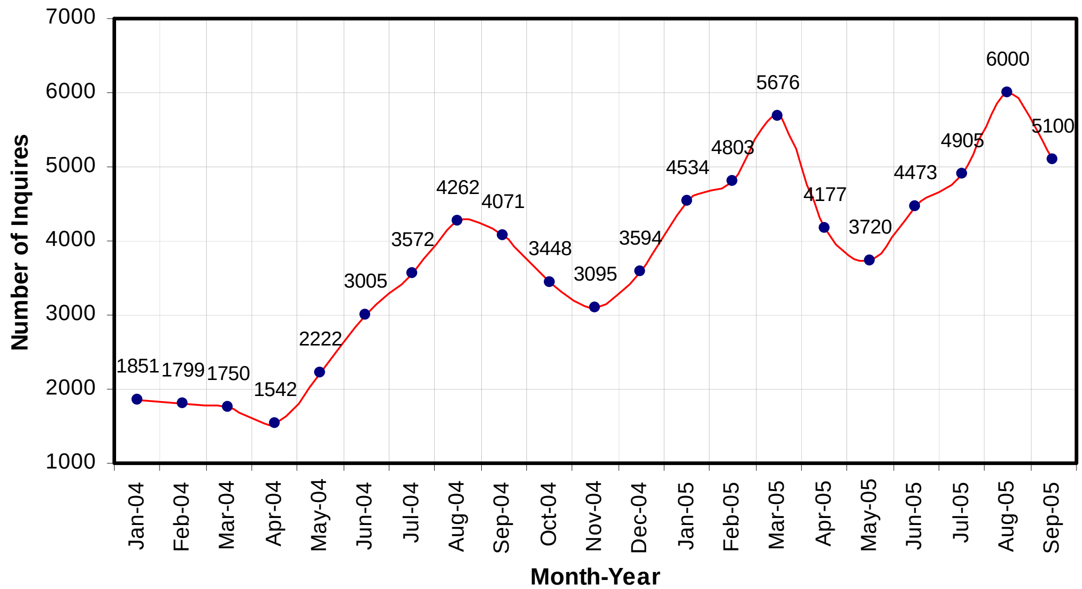

Figure 2: Number of individual PFDS data inquires per month.

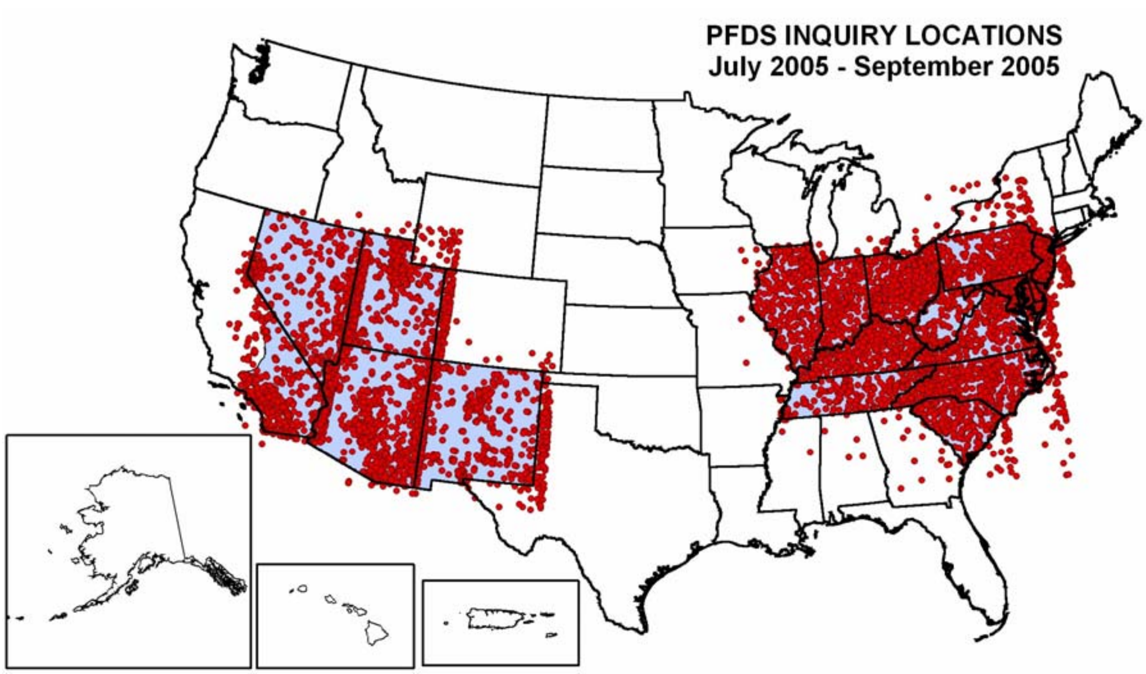

Figure 3: Map of 16,005 PFDS data inquiry locations during the period July-September 2005.

3.3 Areal Reduction Factors

Work continues in the development of geographically-fixed Areal Reduction Factor (ARF) curves for basin area sizes of 10 to 400 square miles. Progress has been slow due to difficulties in completing the software related to the general fit of the underlying ARF curves. Additional basin sites in Alaska, Colorado, Florida, Oklahoma and Texas that could be used in the ARF analysis are being investigated for their availability of sufficient data.

Two statistical and objective testing procedures, the sign test (Himmelblau, 1970) and a modified "student t" test (Spiegel, 1961) were applied to some of the ARF raw data from two sites. The purpose of these statistical tests is to ultimately detect differences in the ARF curves for the various sites. To do this, the "relationships" (group means and standard deviations versus inter-station distances) that are used to "fit" the ARF curves are tested. The theory is that if differences in the relationships that are used to generate the final "fit" (curves) are detected, then it can be concluded that there are differences in the ARF curves for the various sites.

4. Issues

4.1 Recent Presentations

At the invitation of the Corps of Engineers Hydrologic Engineering Center (HEC) Geoff Bonnin participated in a workshop on "Proposed Methods of Generating the Annual Exceedance Probability (AEP) of the Probable Maximum Flood (PMF)." The purpose of the workshop was to discuss the possibility of assigning an average recurrence interval of the PMF for use by the Corps when performing portfolio risk assessment of dams. It was held at HEC in Davis, California on 26-27 July 2005.

4.2 New HDSC List-server

HDSC has created a list-server to send e-mail to a list of subscribers. It will replace our current process for announcements of progress reports, data updates, documentation and publications. Only HDSC personnel will be able to send messages through the server. The address list will not be available to the public. The list-server is not meant to serve as a discussion forum, but is meant to be a tool for HDSC to distribute information. Details on how to subscribe and un-subscribe from our list server are accessible through the HDSC homepage at http://www.nws.noaa.gov/ohd/hdsc. Be aware, if you unsubscribe you will no longer receive announcements of progress reports, documentation or data updates from HDSC.

5. Projected Schedule and Remaining Tasks

The following list provides a tentative schedule with completion dates. Brief descriptions of tasks being worked on next quarter are also included in this section.

1-year Estimates [December 2005]
Spatial Relations (Areal Reduction Factors) [December 2005]

5.1 1-year Estimates

1-year estimates will be calculated and internally reviewed during the next quarter. They will then be made available on the PFDS.

5.2 Areal Reduction Factors (ARF)

Computations for the ARF curves will be completed for 14 areas. The resulting curves will be tested for differences to determine if a single set of ARF curves is applicable to the entire U.S. or whether curves vary by region.

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